NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 6
COURSE CODE: ORC601S	**COURSE NAME:** ORGANIC CHEMISTRY 1
SESSION: JULY 2022	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SECOND OPPORTUNITY/SUPPLEMENTARY EXAMINATION QUESTION PAPER	
EXAMINER(S)	MR. DAVID NANHAPO
MODERATOR:	PROF. HABAUKA KWAAMBWA

INSTRUCTIONS
1. Answer ALL the questions. 2. Write clearly and neatly. 3. Number the answers clearly 4. All written work must be done in blue or black ink and sketches can be done in pencil 5. No books, notes and other additional aids are allowed

PERMISSIBLE MATERIALS

Non-programmable Calculators

ATTACHMENTS

pKa Chart and Periodic Table

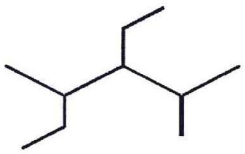
THIS QUESTION PAPER CONSISTS OF 13 PAGES
(Including this front page, pKa Chart and Periodic Table)

SECTION A [50]

QUESTION 1: Multiple Choice Questions **[50]**

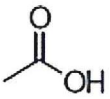
- *There are 25 multiple choice questions in this section. Each question carries 2 marks.*
- *Answer ALL questions by selecting the letter of the correct answer.*
- *Choose the best possible answer for each question, even if you think there is another possible answer that is not given.*

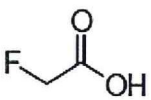
1.1 What is the IUPAC name for the structure below?



A. 3-ethyl-4-methyl-2-hexanol
B. 2-ethyl-1,3-dimethyl-1-heptanol
C. 4-ethyl-3,5-dimethyl-5-hexanol
D. (1-hydroxyethyl)-3-methylhexane

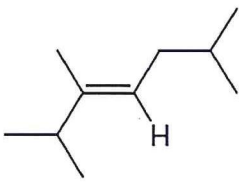
1.2 List the following compounds in the order of increasing acidity.

A. 
B. 

C. CH_3OH
D. 

A. A; B; C; D
B. A; C; B; D
C. A; C; D; B
D. D; C; A; B

1.3 Give the IUPAC name for the following compound.



A. (Z)-2,3,6-trimethyl-2-heptene
B. (Z)-2,3,6-trimethyl-3-heptene
C. (E)-2,3,6-trimethyl-3-heptene
D. (E)-2,3,6-trimethyl-2-heptene

1.4 Does the equilibrium of this reaction lie to the left or right?

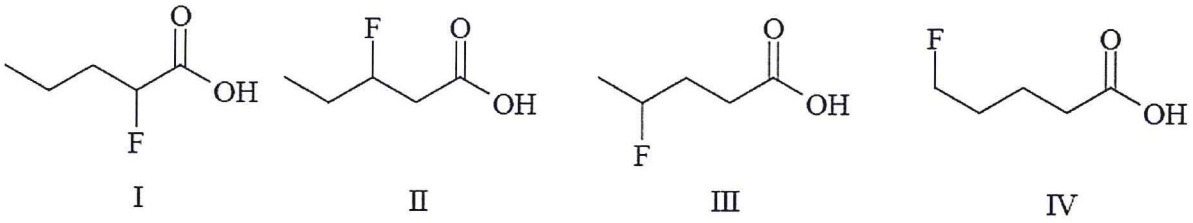
A. Left

B. Right

C. It cannot be determined

D. The forward and reverse reactions are equally favoured.

1.5 Which is the order of increasing acid strength of the following compounds?



A. I, III, II, IV

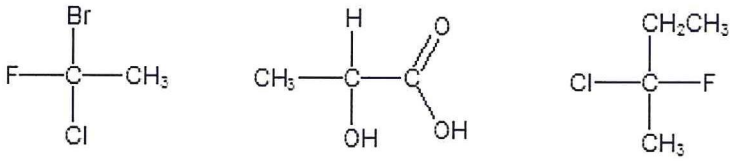
B. IV, III, II, I

C. II, I, III, IV

D. IV, III, I, II

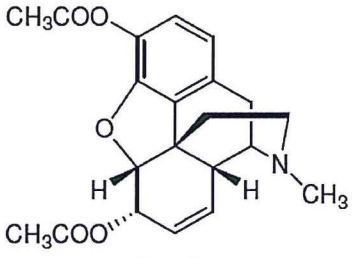
E. III, IV, II, I

1.6 Identify the following compounds as *R* or *S*.



A. S, S, R
B. S, R, S
C. R, S, S
D. S, S, S
E. R, R, R

1.7 How many stereogenic centres does the addictive drug heroin have?



heroin
addicting drug

A. 4
B. 5
C. 6
D. 7

1.8 Consider the three isomeric alkanes *n*-hexane, 2, 3-dimethylbutane, and 2-methylpentane. Which of the following correctly lists these compounds in order of increasing boiling point?

A. 2, 3-dimethylbutane < 2-methylpentane < *n*-hexane
B. 2-methylpentane < *n*-hexane < 2, 3-dimethylbutane
C. 2-methylpentane < 2, 3-dimethylbutane < *n*-hexane
D. *n*-hexane < 2-methylpentane < 2, 3-dimethylbutane
E. *n*-hexane < 2, 3-dimethylbutane < 2-methylpentane

1.9 Among the butane conformers, which occur at energy minima on a graph of potential energy versus dihedral angle?

A. gauche only
B. eclipsed and totally eclipsed
C. gauche and anti
D. eclipsed only
E. anti only

1.10 Given the following substitution reaction, what would the effect be of changing the solvent from ethanol to DMSO?

A. The rate would increase because S_N2 reactions favour a polar aprotic solvent
B. The rate would decrease because S_N1 reactions favour a polar protic solvent
C. The rate would not be affected by the change in solvent.
D. The potential change cannot be predicted

1.11 Which of the following anions is the best leaving group?

A) NH_2^- B) Cl^- C) CH_3^- D) OH^-

A. A
B. B
C. C
D. D

1.12 Which of the following compounds will react most rapidly with HCl?

A. 5-methyl-1-hexene
B. 4-methyl-1-hexene
C. (*E*)-5-methyl-2-hexene
D. (*E*)-2-methyl-3-hexene
E. 2-methyl-2-hexene

1.13 Which of the following is the strongest nucleophile in polar protic solvents?

A) F^- B) CH_3O^- C) HO^- D) CH_3S^-

A. A
B. B
C. C
D. D

1.14 What is the major product from the acid-catalyzed hydration of 2-methyl-2-pentene?

A. 2-methylpentane
B. 2-methyl-1-pentanol
C. 2-methyl-2-pentanol
D. 2-methyl-3-pentanol
E. 1-methoxypentane

1.15 Give the product for the reaction of 1-butene with methanol in the presence of acid.

A. 1-ethoxybutane
B. 2-ethoxybutane
C. 1-methoxybutane
D. 2-methoxybutane
E. 1-butanol

1.19 Which of the following statements is (are) true about an E2 elimination reaction?

A. It is fastest with 3° Halides

B. It exhibits second-order kinetics

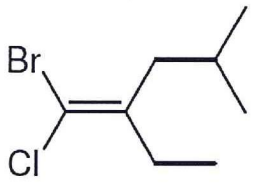
C. A better leaving group should make a faster reaction

D. All of the above are true

1.20 Assuming no other changes, what is the effect of doubling both the alkyl halide and the nucleophile concentrations in a S_N2 reaction?

A. no change
B. doubles the rate
C. triples the rate
D. quadruples the rate
E. rate is halved

1.21 Give the IUPAC name for the following compound.



A. (Z)-1-bromo-2-chloro-2-ethyl-4-methyl-1-pentene

B. (E)-1-bromo-1-chloro-2-ethyl-4-methyl-2-pentene

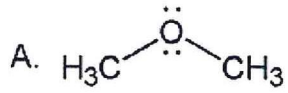
C. (Z)-1-bromo-1-chloro-2-ethyl-4-methyl-1-pentene

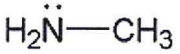
D. (E)-1-bromo-1-chloro-2-ethyl-4-methyl-1-pentene

1.22 Which of the following reaction conditions would result in the anti-Markovnikov addition to the alkene?

A) H_2O/H^+ B) HBr C) HCl D) [1] BH_3; [2] H_2O_2/OH^-

1.23 What is the nucleophilic site in each of the following molecules?

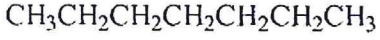
A. 

B. 

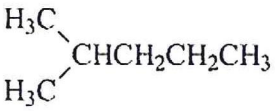
C. 

A) A: hydrogen; B: nitrogen; C: π electrons in bond
B) A: oxygen; B: nitrogen; C: carbon
C) A: oxygen; B: nitrogen; C: π electrons in bond
D) A: oxygen; B: carbon; C: π electrons in bond

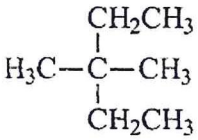
1.24 Which compound has the highest boiling point?



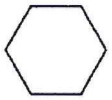
a)



b)

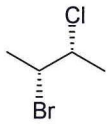


c)



d)

1.25 What is the correct stereochemical name for the following compound?



A. (2S,3S)-2-bromo-3-chlorobutane
B. (2R,3R)-2-bromo-3-chlorobutane
C. (2R,3S)-2-bromo-3-chlorobutane
D. (2S,3R)-2-bromo-3-chlorobutane

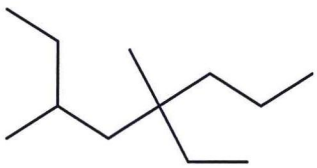
SECTION B: [50]

QUESTION 2 [10]

2.1 Give IUPAC names for the following compounds:

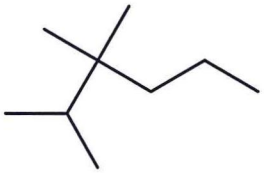
Note: Each question carries 2 marks.

a.

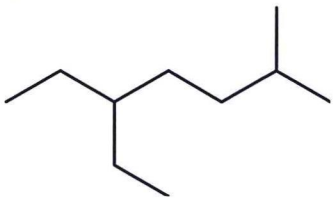


b.

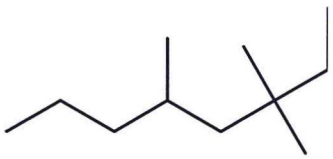
c.



d.



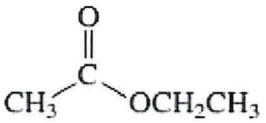
e.



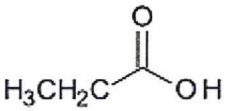
QUESTION 3 [20]

3.1 Give an IUPAC name for the following compounds (6)

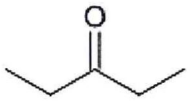
a)



b)



c)



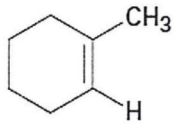
3.2 Draw the skeletal structures of the following molecules. (6)

(a) (4E)-2,4-dimethyl-1,4-hexadiene

(b) cis-3,3-dimethyl-4-propyl-1,5-octadiene

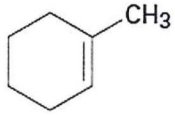
(c) trans-2,2,5,5-tetramethyl-3-hexene

3.3 Predict the products of the following reactions, showing regiochemistry and stereochemistry where necessary. (8)

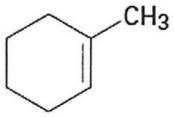
(a) 

$\xrightarrow[2.\ Zn,\ H_3O^+]{1.\ O_3}$?

(b) 
$\xrightarrow[H_3O^+]{KMnO_4}$?

(c) 

$\xrightarrow[2.\ H_2O_2,\ ^-OH]{1.\ BH_3}$?

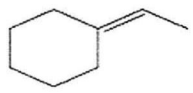
(d) 

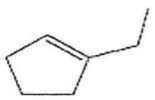
$\xrightarrow[2.\ NaBH_4]{1.\ Hg(OAc)_2,\ H_2O}$?

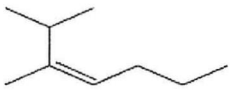
QUESTION 4 **[10]**

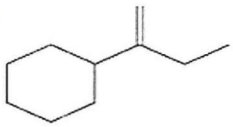
Predict the products of the following reactions. Indicate the stereochemistry in the products when relevant.

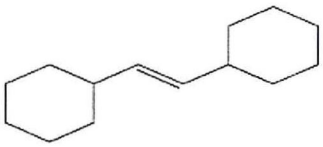
Note: Each question carries 2 marks.

(a) 
$\xrightarrow{H_2O,\ H_2SO_4}$

(b) 
$\xrightarrow[H_2O]{Br_2}$

(c) 
$\xrightarrow[(2)\ NaOH,\ H_2O_2]{(1)\ BH_3:THF}$

(d) 
$\xrightarrow{Br_2}$

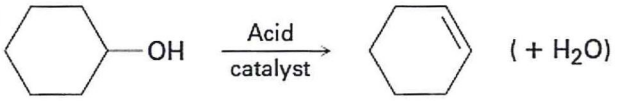
(e) 
$\xrightarrow[(2)\ Me_2S]{(1)\ O_3}$

QUESTION 5 **[10]**

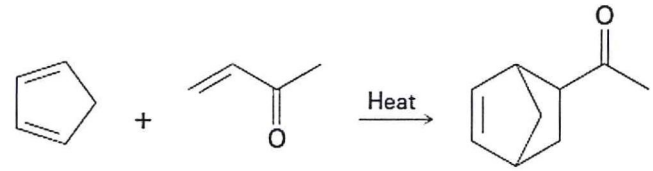
5.1 Identify each of the following reactions as addition, elimination, substitution or rearrangement. (4)

(a) $CH_3CH_2Br + NaCN \longrightarrow CH_3CH_2CN + NaBr)$

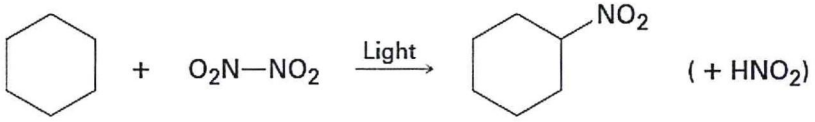
(b)



(c)



(d)

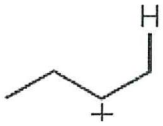
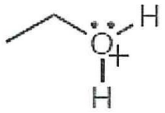
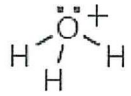
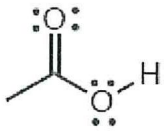
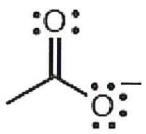


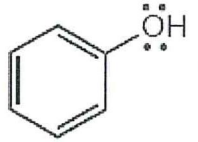
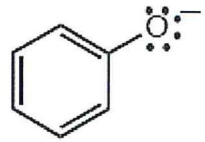
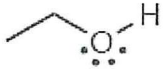
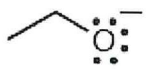
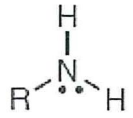
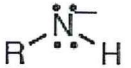
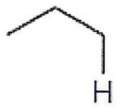
5.2 Using skeletal structures, draw a full detailed mechanism of the reaction of 1-propene with ethanol in the presence of hydrochloric acid. In order to receive full marks, show the flow of electrons using arrows and all the intermediates which are formed during the reaction. (6)

Hint: the reaction produces an alkyl halide and an ether as products

END OF EXAMINATION QUESTIONS

pKa Chart

conjugate acid		conjugate base	
sulfuric acid	H_2SO_4	HSO_4^-	**-10**
hydroiodic acid	HI	I^-	**-9**
hydrobromic acid	HBr	Br^-	**-8**
hydrochloric acid	$H\ddot{C}l:$	$:\ddot{C}l:^-$	**-7**
carbocations			**-3**
protonated alcohol			**-2.4**
hydronium ion			**-1.7**
nitric acid	HNO_3	NO_3^-	**-1.3**
hydrofluoric acid	HF	F^-	**3.2**
carboxylic acids			**4.8**

conjugate acid		conjugate base	
hydrogen cyanide	$H-C\equiv N:$	$:\bar{C}\equiv N:$ (cyanide)	**9.1**
phenols			**10**
water		$^-:\ddot{O}-H$ (hydroxide)	**15.7**
primary alcohols		 (alkoxides)	**16**
alkynes	$C\equiv C-H$	$C\equiv C:^-$ (acetylide anions)	**26**
hydrogen	$H-H$	$:H^-$ (hydride)	**35**
ammonia/amines		 (amide bases)	**36**
alkanes			**~60**

hydrogen 1 **H** 1.0079																	helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122											boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305											aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078	scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62	yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 **	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	ununnilium 110 **Uun** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]			

*Lanthanide series	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
**Actinide series	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]